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### 3.1 Overview

This section addresses subsurface investigation that includes drilling and excavation of test pits as part of a geotechnical field investigation. It is organized by activities and policies involved prior to, during, and after exploration.

### 3.2 Activities and Policies – Before Exploration

Once an exploration plan has been formulated as specified in **WSDOT GDM Chapter 2**, a formal request is provided by the geotechnical designer to the Field Exploration Manager (FEM) for estimating and scheduling that includes the information identified in **WSDOT GDM Chapter 2** regarding the field exploration plan. The site should then be jointly field reviewed by the geotechnical designer and the assigned Field Exploration Supervisor (FES) to determine how each individual exploration site will be accessed, the type of drill equipment best suited for the site, areas for utility locates, required traffic control, and necessary permits (i.e., Right-of-Entry, environmental). Based on this joint field review, the FEM will provide a cost estimate to the geotechnical designer to complete the field exploration plan. Once the expenditure for the field exploration has been authorized, the geotechnical designer must then notify the FEM to commence with the field exploration. Once the exploration plan has been executed, any subsequent requests to modify the plan should be provided in writing by the geotechnical designer to the FES. The FES will respond with an updated estimate and schedule for requested plan change.

The Region is responsible for tasks that should be completed in advance of the scheduled start of work by the Geotechnical Division. Prior to completion of the exploration plan, the region is responsible to make sure that the previous use of the site has been investigated, in particular with regard to the potential to encounter hazardous subsurface materials and to encounter artifacts of historical significance. The FEM (or as delegated to an FES) is responsible to coordinate with the geotechnical designer and the appropriate region office to make sure that these tasks are completed. In addition, the FEM (or as delegated to an FES) is responsible to coordinate with the appropriate region office to make sure that the following tasks are completed:

- Real Estate Services is responsible for acquiring the proper Right of Entry (ROE) on any non-WSDOT property. The Region shall notify our FEM with any questions pertaining to any impact to the property with our drilling operation.
- The Region Environmental Section is responsible for obtaining all necessary required environmental permits. Currently, WSDOT has a five-year blanket Hydraulic Project Approval (HPA) for both marine and fresh waters statewide. Once again the FEM or FES should be involved early in the process to define all technical questions for each project.

For all barge projects, the drilling shall be in compliance with the provisions described in the general HPA from the Washington Department of Fish and Wildlife (WDF&WL).

On the initial site visit, the FES will stake the borings if they have not already been located and assess the traffic control needs for the exploration work. The FES will coordinate directly with the Maintenance Office for traffic control. After staking borings, the FES is responsible for calling all utility locates a minimum of 48 hours prior to the start of explorations.

The FEM (or as delegated to a FES) will assign the project to a drill inspector(s) and a drill crew. The drill inspector will then initiate a meeting with the geotechnical designer to discuss the objectives and any particulars of the exploration plan. Either the FES or the drill inspector should notify the geotechnical designer of the anticipated start date of the requested work.

### **3.3 Activities and Policies – During Exploration**

The drill inspector will maintain regular contact with the geotechnical designer, especially when unanticipated conditions or difficulties are encountered, significant schedule delays are anticipated, and prior to terminating the exploration and installing instrumentation. The driller is required to complete a daily drill report at the end of each workday. This is also required of any contract driller working for WSDOT. The drilling inspector is also required to complete a daily inspector's report at the end of each workday. At the completion of each workweek these reports shall be turned in to the FES and put in the project file. Examples for both the daily drill and inspector reports that show the minimum required documentation are included in **WSDOT GDM Appendix 3-A**.

Exploration activities during drilling must adhere to the Geotechnical Division's Best Management Practices to mitigate for sediment/erosion control and spill prevention (see **WSDOT GDM Appendix 3-B**).

Methods for advancing geotechnical borings should be in accordance with the following ASTM standards:

- D6151-97(2003) Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
- D5876-95(2000) Standard Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
- D2113-99 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation

Hollow-stem augers are not to be used for assessment of liquefaction potential; wet rotary methods should be used. Further, care must be exercised during drilling with hollow-stem augers to mitigate for heave and loosening of saturated, liquefiable soils.

Sampling of subsurface materials should be in accordance with the following ASTM standards:

- D1586-99 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
- D3550-01 Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
- D1587-00 Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
- D4823-95(2003)e1 Standard Guide for Core Sampling Submerged, Unconsolidated Sediments

In addition to the methods described above for sampling for soft, fine-grained sediments, WSDOT utilizes a thick-walled sampler referred to as the Washington undisturbed sampler. This sampler is lined with 2-inch (I.D.) extrudible brass tubes. The sampler is intended for stiffer fine-grained deposits than what would be suitable for Shelby tubes.

Down-the-hole hammers are not allowed for use in performing Standard Penetration Tests.

Samples should be handled in accordance with the following ASTM standards:

- D4220-95(2000) Standard Practices for Preserving and Transporting Soil Samples
- D5079-02 Standard Practices for Preserving and Transporting Rock Core Samples

Disturbed soil samples should be placed in watertight plastic bags. For moisture-critical geotechnical issues, a portion of the sample should be placed in a moisture tin and sealed with tape. Extreme care must be exercised when handling and transporting undisturbed samples of soft/loose soil; undisturbed samples must also be kept from freezing. Rock cores of soft/weak rock should be wrapped in plastic to preserve in situ moisture conditions. Rock cores should be placed in core boxes from highest to lowest elevation and from left to right. Coring intervals should be clearly labeled and separated. Core breaks made to fit the core in the box must be clearly marked on the core. All soil and rock samples should be removed from the drill site at the end each day of drilling and transported to the laboratory as soon as possible.

In situ testing methods commonly employed in geotechnical investigations should be in accordance with the following ASTM standards:

- D2573-01 Standard Test Method for Field Vane Shear Test in Cohesive Soil
- D5778-95(2000) Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils

Groundwater monitoring and in situ characterization methods commonly employed in geotechnical investigations should be in accordance with the following ASTM standards:

- D5092-02 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers
- D4750-87(2001) Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)
- D4044-96(2002) Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

As a minimum, groundwater levels should be measured/recorded prior to the daily commencement of drilling activities and upon completion of piezometer installation. Subsequent monitoring is at the discretion of the geotechnical designer. Prior to constructing a piezometer, the boring should be thoroughly purged of drill fluids using clean, potable water. The geotechnical designer should provide design input on the construction of the piezometer, specifically regarding the screened interval and seals. Piezometers shall be constructed in accordance with Washington Department of Ecology (DOE) regulations (RCW 18.104 /WAC 173.160) governing water wells. Following completion of the piezometer, the piezometer should be repeatedly surged or bailed to develop the well screen and optimize hydraulic connectivity with the formation.

Slope inclinometers are routinely employed for slope stability investigations. The installation and monitoring of slope inclinometers should be in accordance with the following ASTM Standard:

- D6230-98 Standard Test Method for Monitoring Ground Movement Using Probe-Type Inclinometers

Explorations using hand equipment such as augers and drive probes may also be useful for some geotechnical investigations, such as to define lateral and vertical extent of soft/loose, near-surface deposits. The WSDOT portable penetrometer consists of 1.75 inch diameter rod which tapers to a rounded 0.5 inch tip over a 4.5 inch length, that is driven in the ground with a 35 lb weight dropped from a 30 inch height. Standard Penetration Test correlations for the WSDOT portable penetrometer (PP) are approximated as follows:

Soil Type	SPT Correlation
Clay	# PP blows/4
Silt	# PP blows/3
Sand/Gravel	# PP blows/2

The excavation of test pits can provide valuable subsurface information not determinable or well characterized by test borings. Extreme care should be exercised around open excavations, and access within them should adhere to Washington Administrative Code (WAC) sections 296-155-655 and 296-155-657.

Prior to de-mobilizing, the drill inspector should ensure location information (e.g., station, offset, elevation and/or state plane coordinates) of all the explorations are recorded on the field logs. If exact location information is unavailable upon completion of field activities, a sketch of each exploration location should be made indicating relationship to observable features (i.e., bridge/structure, mile post, etc.). This information should be provided with the field logs to the geotechnical designer. In addition to providing field logs for all explorations, required documentation for test pits should include a scale drawing of the excavation and photographs of the excavated faces. Sampling methods and in situ measurement devices such as pocket penetrometers should also be documented. Detailed requirements for boring logs are provided in **WSDOT GDM Chapter 4**.

### **3.4 Activities and Policies – After Exploration**

Upon completion of subsurface explorations, a finished log for each exploration is to be sent to the Department of Ecology (DOE) by the FES. In addition to subsurface conditions encountered, the log must include location (address, county, and  $\frac{1}{4}$  -  $\frac{1}{4}$  Section/Township/Range) and installation information (well #, type of instrumentation, seals, and screened interval).

Unless otherwise requested by the geotechnical designer, all explorations and resource protection wells (piezometers and inclinometers) shall be properly decommissioned prior to construction as per DOE requirements (WAC 173-160-381,500 and RCW 18.104.048). The construction Project Engineer is responsible for notifying the FEM at least 72 hours prior to required time for decommissioning.

Upon completion, the drilling inspector shall transmit recovered samples to the Geotechnical Division lab and provide both the original copy of the field notes and a finished log for all explorations to the geotechnical designer.

# Appendix 3-A

# Daily Drill Report Form



Washington State  
Department of Transportation

## DAILY DRILL REPORT

SR _____ CS _____					DATE _____		
PROJECT _____						PROJECT NO. _____	
DRILL _____						DRILL NO. _____	
<input type="checkbox"/> STRUCTURE		<input type="checkbox"/> LINE		<input type="checkbox"/> LANDSLIDE		<input type="checkbox"/> MATERIALS SOURCE	
SOLE NO.	SIZE	ANGLE	FROM	TO	SOIL	ROCK	TOTAL
ITEM			HOURS	ITEM			HOURS
MOBILIZATION AND DEMOBILIZATION				WATER HAUL : MILEAGE			
ON SITE MOVING / RIGGING				EQUIPMENT DOWNTIME			
DRILL SITE PREPARATION				EXPLAIN:			
SOIL DRILLING				STANDBY FOR HOLE SURVEY AND OTHER DELAYS			
ROCK DRILLING				EXPLAIN:			
REAMING HOLE				INSTALLATION OF INSTRUMENTATION			
PLACING AND REMOVING CASING				TYPE:			
HOLE STABILIZATION				SPECIAL TESTING			
INSTALL AND MAINTAIN WATER SYSTEM				TYPE:			
WATER DELAY				TRAVEL TIME			
EXPENDIBLES							
CORE BOXES		PEZO PIPE		SLOPE INCL.		CEMENT	
OTHER							
SUPPORT EQUIPMENT				NO.	JOB	YARD	O SERV.
REMARKS							
INSPECTOR				REG.	O.T.	COMP	TOTAL
DRILLER				REG.	O.T.	COMP	TOTAL
HELPER				REG.	O.T.	COMP	TOTAL
SHIFT START		SHIFT FINISH		SERVICE CODES			

DOT 350-152 3/89 DISTRIBUTION: Original — File Canary — Drill Superintendent Pink — Job



**Washington State  
Department of Transportation**

## Inspector's Daily Report

IDR Sheet	of	Sheets	Final Record Book	Page
Contract		Day		Date

DIARY - Including but not limited to: a report of the day's operations, time log (if applicable), orders given and received, discussions with contractor, and any applicable statements for the monthly estimate.

DOT Form 422-004A EF  
Revised 1/94

Signed \_\_\_\_\_

Inspector \_\_\_\_\_



## **Appendix 3-B**

# **Field Investigation Best Management Practices for Erosion and Spill Prevention**

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The Washington State Department of Transportation (WSDOT) is dedicated to protecting the environment when conducting field exploration projects. This memo outlines the erosion/sediment control and spill prevention best management practices (BMPs) that will be followed for all drilling activities.

The two distinct scenarios for drilling include pavement and vegetated areas. The variety of erosion and sediment control BMPs may vary between the two scenarios, but the philosophy of minimizing site disturbance, reducing waste materials, trapping sediment, and stabilizing the site, remains the same.

### **Disturbance Minimizing BMPs:**

- Select the smallest rig capable for the job
- Use elevated scaffolding for driller and assistant when necessary

### **Waste Reduction BMPs:**

- Re-circulate drilling slurry
- Minimize volume of water for drilling

### **Sediment Trapping BMPs:**

- Baffled mud tub (sealed with bentonite to prevent fluid loss)
- Polyacrylamide (PAM) for flocculation (must meet ANSI/NSF Standard 60)
- Silt fence (trenched, below drill, and on contour)
- Sand bag barrier (washed gravel, below drill, two rows high, and on contour)
- Straw bale barrier (trenched, staked, below drill, and on contour)
- Catch basin insert (pre-fabricated type, above or below grate)
- Storage of slurry in locked drums

### **Site Stabilization BMPs:**

- Seed with pasture grass
- Straw mulch (2" maximum for seeded areas)

All BMPs will be installed and a thorough inspection for sensitive areas (wetlands, streams, aquifer recharge, etc) and stormwater conveyances will be conducted, prior to starting drilling activities. At no time shall drilling slurry or cuttings be allowed to enter Water Bodies of the State of Washington.

When sensitive resources or conveyances to these areas exist, all slurry and cuttings will be stored in lockable drums and disposed of off-site. If not, the slurry will slowly be infiltrated into the ground using surrounding vegetated areas and the cuttings will be stored and disposed of off-site.

Removal of sediment control BMPs will be performed immediately after drilling is completed. Place

trapped sediment with cuttings in drums. If significant soil disturbance occurs during drilling, the BMPs will be left in place until the site is stabilized with grass or mulch.

The drill crew will have a copy of the Hydraulic Project Approval (HPA), issued by the Washington State Department of Fish and Wildlife (WDFW) on-site for all work adjacent to or over water. The Supervisor will discuss the requirements of this permit with the crew prior to each project. All of the provisions in each HPA will be strictly followed until the completion of said project. The previously defined erosion/sediment control philosophy and BMPs will be implemented in these conditions

The approach to protecting surface and ground water is focused on prevention. The drill shaft will be filled with bentonite clay to prevent mixing of aquifers and eliminating the route for surface contaminants. In addition, the following Spill Prevention Control & Countermeasures (SPCC) BMPs will be used when applicable:

**Minimize Risk:**

- Visually inspect equipment for leaks or worn hoses on a daily basis
- Fix equipment leaks as soon as possible to minimize cleanup
- Use proper equipment to transfer materials
- Reduce the overall volume of fuel and chemicals on site
- Remove as many sources of spills as possible from the site when not working (evenings/weekends)
- Use environmentally-friendly chemicals whenever possible
- Store all chemicals with lids closed and keep containers under cover
- Have secondary containment devices underneath potential spill sources when applicable (i.e. 5 gallon bucket)

**Maximize Response:**

- Each drilling operation will have at least one emergency spill response kit on site at all times
- Know who to call in case of emergency spill

If an incidental spill (less than 1 gallon/small equipment leak) occurs, immediately collect contaminated soil and store it in label storage drum. Do not mix soils with different contaminants together. Report spill to your supervisor, as they are aware of reporting requirements.

If a major spill (more than 1 gallon) to water occurs, control the source of the leak if possible and contact the Washington State Emergency Management Division (800-258-5990) and the National Response Center (800-424-8802). If a major spill to soil occurs and there is immediate risk to human health and/or the environment, control the source of the leak if possible and contact the Washington State Department of Ecology (800-407-7170). Then contact your supervisor, as they are aware of reporting requirements.